JBR Environmental Consultants, Inc.

Technical Memo

To: John Wagner, Brush Resources, Inc.

From: Robert J. Bayer

Date: April 20, 2006

Re: Summary of Slope Stability Studies, Topaz Beryllium Mines

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Dr. Kim McCarter prepared for Brush Resources, Inc. (BRI) two reports that evaluated open pit slope stability at two existing open pits at the Topaz mine:

Fluro Pit Expansion Fracture Survey, 2002

Rainbow Pit Strength and Fracture Summaries, 1998

While the text of Dr. McCarter's reports is brief, they are supported by extensive field measurement records and interpretive graphics. The 1998 Rainbow report is accompanied by a report entitled "Shear Strength and Uniaxial Compressive Strength Rainbow Pit Expansion," which describes the results of testing of cores from two drill holes in altered volcanic rocks.

The various reports provided conclusions regarding slope stability that were used in developing the designs for the Phase I LMU pits for both the Fluro and Rainbow pits and the overall mine planning model for the entire mine property.

General Technical Approach

Data collected for the Fluro and Rainbow pit studies consisted of descriptions and orientation measurements for fractures, joints and faults. These data were compiled using stereographic projections. The core test work consisted of laboratory analysis for shear and compressive strength. The stereographic projections were used to compile and represent fracture attitudes measured in the pit areas and identify plane orientations of the various fractures sets. The data were used to develop understandings of the relationships of potential slope failures to the various fracture sets and to provide recommendations for pit slope design.

Mine Geology Background

The various ore bodies in the mine area are associated with high-angle normal faults, which are believed to have been the conduits for hydrothermal solutions responsible for mineralization of the beryllium tuff and the alteration of the overlying rhyolites and nearby latites or rhyodacites. These faults have displaced the beryllium tuff horizon and formed the series of half grabens that resulted in the isolation of the individual ore bodies at the mine and brought some of the orebodies closer to the surface. All of the major faults are subparallel to one another and have a consistent eastward dip direction. The relationship of faulting to ore bodies is readily apparent from viewing the geology map.

Faults mapped by Lindsey that are associated with the ore bodies generally strike between north 45° east and north 75° east, with local variations. The cross sections on the geologic map depict the relationship of the ore-bearing beryllium tuff and the overlying rhyolite to the faults. These faults define the primary structural fabric at the mine property.

The geologic map in the Brush MRP, Plate 1, has been revised to show the outlines of the ultimate pit development for the currently anticipated life. In addition the geologic map has been modified to more accurately reflect fault traces using drilling data and more recently collected data on the attitude of major faults exposed in various open pits in the mine area.

Measurements of the strike and dip of exposed fault planes in the mine area have recently been collected by BRI mine staff. Additional faults were measured from the lithology models in the Minex mine and mineral deposit modeling software in places where they are not exposed. These measured dips are shown on the revised version of Plate 1, the Geologic Map, and are also summarized below:

Section 16 North #1 Pit	North 34 East @ 54°E
Blue Chalk North #2 Pit	North 49 East @ 57°E
Rainbow Pit	North 56 East @ 42°E
Fault Zone south of Rainbow	North 69 East @ 55°E
Monitor Pit	North 49 East @ 33°E
	North 75 East @ 64°W
South Wind	North 49 East @ 49°E

The strike and dip measurements for the Section 16 and Blue Chalk pit faults are actually an average of a number of exposures of single faults or closely spaced parallel faults in a particular fault zone.

The geologic map shows three different categories of mapped faults. The thick black lines are the traces of the faults mapped by Lindsey (1979). Lindsey did not use any data from BRI's extensive exploratory and development drilling at the site in order to prepare his map. Lindsey's mapping can be considered as accurate as possible given the nature of the bedrock exposures and extensive alluvial cover in the mine area. Although further work by BRI has demonstrated that some fault traces mapped by Lindsey are locally inaccurate, no effort has been made to revise or edit his work. The second fault category, shown in a narrow blue line, consists of faults recognized by BRI's former geologist, Mr. Lee Davis, and located based on aerial photograph, surficial geology and drill hole data. The faults in the third category are the modified fault traces based on data from closely spaced drill holes in the open pit areas. Those faults are depicted in a wider blue line and are generally the major ore-displacing fault in each of the proposed ultimate pits. Where the faults cross pit locations they are shown on the map in green.

Findings and Interpretations

Dr. McCarter's reports were focused on the specific pit developments contemplated or in progress at the time the reports were completed. The study at the Rainbow pit was carried out in part due to the highwall failure that had previously occurred there. This slope failure was one of the two slope failures that have occurred during mining operations that are described in general in section 8.2 of the MRP. The primary intent of the Rainbow pit study was to "establish the preferred orientation of geotechnical features present in the rhyolite" for use in "selecting an appropriate pit angle for pit planning purposes."

The Rainbow pit report identified the following risks for potential slope failures and mitigating measures:

- Failures on "localized near-horizontal weak zones in the altered rhyolite" – if they dip into the pit at angles greater than 15 degrees; potential for failure would be greatly reduced by designing benches to "follow the down-dip component of the tuff bed;"
  - ***Using the study results****, the longest highwall segment in the Rainbow Phase I LMU pit is designed to trend approximately N18°E and it follows the down-dip component of the tuff bed. As a result, the risk of low-angle slope failures is low.*
- The set of fractures with orientations similar to that of the major fault on the west side of the pit may result in failures for pit benches trending N0°E to N45°E if pit slope angles result in these fractures day-lighting on the pit wall. Failure probabilities are stated to be less than 50% for slopes angles less than 55°. Nevertheless, the report cautions that the failure associated with the major fault, which locally dips at 45° to the southeast, demonstrates that a 50% probability is not an indicator of pit slope stability.
  - *The highwall slopes for the Rainbow Phase 1 LMU pit are designed at from 40 to 43 degrees (measured from topographic map on Plate 7C of MRP). According to McCarter's report, these slopes would then have a failure probability of 5 % or less. The pit slopes for the Phase I LMU pits were designed by a consulting professional mining engineer, specializing in geological engineering and open pit design, after considering the results of Dr. McCarter's work.*

The second report, entitled "Shear Strength and Uniaxial Compressive Strength Rainbow Pit Expansion," describes the results of testing of cores from two drill holes in altered volcanic rocks. This report describes the results of testing of cores from altered latite and altered rhyolite in the Rainbow deposit. The tests were conducted to assess the influence of the altered volcanics on pit slope stability. The test results were used to design the pit slopes for the Rainbow pit expansion as planned in April 2000; the design slope angles derived from the test results are shown on the map at the end of this report. As this map indicates, recommended highwall slope angles are 42 and 43 degrees. *Note that the slope angles for the Phase 1 LMU Rainbow pit described in the preceding paragraph are equal to or less than the slope angles recommended by Dr. McCarter in this report.*

The Fluro pit study concluded that:

- Joint strength is relatively high in the Fluro pit;
- Wedge failures are likely to be bench scale;
- Large scale instability through planar failure is most likely to occur at slopes facing due east with slope angles greater than 50°; fracture sets with strikes that are nearly north-south having average eastward dips of 52 to 53 degrees would lead to slope failures with slope alignments and angles that exceed or closely approach the orientation of these fracture sets.

- *The highwalls for the Fluro LMU pit are all designed at less than 50 degrees and range from 45 to 48 degrees (measured form topographic map on Plate 10). None of the slopes face due east; slope face directions are 50°, 78°, and 110°, azimuthal.*

The strength data collected for the altered rhyolite and latite cores are likely to be representative of the altered volcanics in all ore bodies; the uniformity of the alteration mineralogy associated with the various ore bodies is documented in the literature (Lindsey, 1979) and lithologic consistency has been recognized by BRI mining staff in both closely spaced drill hole samples and in highwalls.

The relationship of the fracturing in the Fluro and Rainbow ore bodies to the major faults in their vicinity is demonstrated both by proximity and the relationship of the planar orientations of the fractures and faults (e.g., note that the dip directions of five of six planar orientations measured in the Fluro pit are east-south, as are the dips of the major faults associated with the various ore bodies). The structural fabric in the area is clearly defined by the pattern of faulting.

McCarter's evaluations and recommendations combined with BRI's experience in open pit development without the occurrence of post-mining pit slope inter-bench instability provide clear evidence that open pits with slopes somewhat in excess of 45 degrees can be safely constructed at the Topaz mine. Because all of the initial LMU pits have been designed with slopes that do not exceed 50 degrees, the pit slopes appear to be designed with appropriate conservatism and these proposed pits, like the existing pits, are likely to remain stable long after mining is completed.